

# FINAL

## TECHNICAL PROGRESS REPORT

### **For the period:**

April 1, 1997 – June 30, 1997  
2nd Quarter

### **Prepared for:**

Rosebud SynCoal Partnership  
Advanced Coal Conversion Process Demonstration  
Colstrip, Montana

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## 1.0 INTRODUCTION AND PURPOSE

This report describes the technical progress made on the Advanced Coal Conversion Process (ACCP) Demonstration Project from April 1, 1997 through June 30, 1997.

The ACCP Demonstration Project is a U.S. Department of Energy (DOE) Clean Coal Technology Project. The Cooperative Agreement defining this project is between DOE and the Rosebud SynCoal Partnership. In brief, Western Energy Company, which is a coal mining subsidiary of Entech, Inc., Montana Power Company's (MPC's) non-utility group in Colstrip, Montana, was the original proposer for the ACCP Demonstration Project and Cooperative Agreement participant. To further develop the ACCP technology, Entech created Western SynCoal Company. After the formation of the Rosebud SynCoal Partnership, Western Energy Company formally novated the Cooperative Agreement to the Rosebud SynCoal Partnership to facilitate continued participation in the Cooperative Agreement. The Rosebud SynCoal Partnership is a partnership between Western SynCoal Company and Scoria, Inc., a subsidiary of NRG Energy, Inc., Northern States Power's non-utility group.

This project demonstrates an advanced, thermal, coal upgrading process, coupled with physical cleaning techniques, that is designed to upgrade high-moisture, low-rank coals to a high-quality, low-sulfur fuel, registered as the SynCoal<sup>®</sup> process. The coal is processed through three stages (two heating stages followed by an inert cooling stage) of vibrating fluidized bed reactors that remove chemically bound water, carboxyl groups, and volatile sulfur compounds. After thermal upgrading, the coal is put through a deep-bed stratifier cleaning process to separate the pyrite-rich ash from the coal.

The SynCoal<sup>®</sup> process enhances low-rank, western coals, usually with a moisture content of 25 to 55 percent, sulfur content of 0.5 to 1.5 percent, and heating value of 5,500 to 9,000 British thermal units per pound (Btu/lb), by producing an upgraded, coal product with a moisture content as low as 1 percent, sulfur content as low as 0.3 percent, and heating value up to 12,000 Btu/lb.

The 45-ton-per-hour unit is located adjacent to a unit train loadout facility at Western Energy Company's Rosebud coal mine near Colstrip, Montana. The demonstration plant is sized at about one-tenth the projected throughput of a multiple processing train commercial facility.

## 2.0 PROJECT PROGRESS

### 2.1 SIGNIFICANT ACCOMPLISHMENTS

Rosebud SynCoal Partnership's ACCP Demonstration Facility entered Phase III, Demonstration Operation, in April 1992 and operated in an extended startup mode through August 10, 1993, when the facility became commercial. The Rosebud SynCoal Partnership instituted an aggressive program to overcome startup obstacles and now focuses on supplying product coal to customers. Significant accomplishments in the history of the SynCoal® process development are shown in Appendix A. Table 2.1 lists the significant accomplishments for the year to date.

Table 2.1. Significant Accomplishments for 1997

<b>2<sup>nd</sup> Quarter</b>	<b>Significant Accomplishments</b>
<b>April, 1997</b>	<ul style="list-style-type: none"><li>• <b>The SynCoal facility produced its one millionth ton of SynCoal®</b></li></ul>
<b>May, 1997</b>	<ul style="list-style-type: none"><li>• <b>Conducted a coke/SynCoal® blend test</b></li></ul>
<b>June, 1997</b>	<ul style="list-style-type: none"><li>• <b>None to Report</b></li></ul>
<b>1st Quarter</b>	<b>Significant Accomplishments</b>
<b>January, 1997</b>	<ul style="list-style-type: none"><li>• None to Report</li></ul>
<b>February, 1997</b>	<ul style="list-style-type: none"><li>• None to Report</li></ul>
<b>March, 1997</b>	<ul style="list-style-type: none"><li>• Conducted ash yield tests for Globe Metallurgical</li><li>• Completed pneumatic unloading test at Montana Power Units 1 and 2</li><li>• T-96 silo gate modifications were completed.</li></ul>

### 2.2 PROJECT PROGRESS SUMMARY

During the life of the ACCP Demonstration project, over 950,000 tons of SynCoal® products which include regular, fines, blend, DSE treated and special high sulfur SynCoal® has been shipped to various customers. The plant has maintained a perfect record with customers in being able to provide the amount of product they have requested.

In April, the ACCP Demonstration Project produced its One Millionth Ton of SynCoal®. A luncheon to honor the plant employees was held at the ACCP site on June 27. In addition to the plant employees, all mine employees, SynCoal® customers, the Department of Energy, and others having made a significant contribution to the success of the plant were invited.

The production of the one million tons of SynCoal<sup>®</sup> was done with no lost time accidents – well over 300,000 manhours. The plant has boosted the local and regional economy with approximately \$8.5 million in wages; \$2 million in production taxes, \$18 million in materials and supplies purchased and \$40 million in construction costs.

Methods of obtaining samples for lab analysis of the SynCoal<sup>®</sup> product being loaded out of the silo has been studied to provide a more uniform reporting system for all samples. Testing of the product sampling system determined that the automated mechanical sampler on C908 is much more accurate than the truck sampling technique. The truck customers agreed to use the daily silo input samples for the contract basis. Separate samples will be taken for rail shipments. Lab analyses will no longer be by customer.

A primary focus of the ACCP Project team has continued to be the operation of the ACCP Demonstration facility. The excess production capacity is now being sold to Units 1 & 2 in Colstrip, Montana. The sale of SynCoal<sup>®</sup> fines has emerged as a critical requirement to future operations. Coarse/fines blend testing has given positive indications and discussions with Colstrip Units 1 & 2 are now in progress for design and installation of a pneumatic feed system. Tests were conducted on the pneumatic unloading of regular SynCoal<sup>®</sup> to Units 1 and 2.

Market awareness and acceptability for both the products and the technology are still a primary goals. The ACCP Project team has continued to focus on improving the operation, developing commercial markets, and improving the SynCoal<sup>®</sup> products as well as the product's acceptance. Operational improvements are currently aimed at increasing throughput capacity, decreasing operating costs, and developing standardized continuous operator training programs. The use of covered hopper cars has been successful and marketing efforts have focused on using this technique. Marketing efforts are targeted at developing markets for the SynCoal<sup>®</sup> fines product and longer term industrial contract sales.

The inert gas system which was installed in 1994, continues to display operational problems. The installation of a LeROI compressor was completed; however, performance testing has not been performed because of a variety of mechanical problems that needed to be corrected before testing.

The ACCP waste disposal plan was submitted to the Montana Department of Environmental Quality in September. This draft included responses to their comments on an earlier draft. This waste disposal plan received approval on April 25, 1997 from the MDEQ.

During the second quarter, the plant processed approximately 117,411 tons of raw coal, and the facility's quarterly average operating availability was 79.2%. The raw coal feed average rate was 68.7 tons per hour for the quarter and the plant achieved a 106% feed capacity factor. Totally to date, about 1,621,990 tons of raw coal have been processed. For the second quarter of 1997, the plant produced about 77,537 tons of product of which 63,440 tons were coarse product

and 14,097 tons of fines. Approximately 956,540 tons have been shipped to date, with 72,570 tons shipped during the second quarter of 1997.

Modifications and maintenance work was performed in the following areas during the Second Quarter of 1997.

- Repair broken belt on C-0-26 dust conveyor
- Repair broken chain on C-0-26 drag conveyor
- Relocate slurry pump P-10
- Replace refractory in furnace
- Repair C-0-28 chain
- Repair P-0-8 pump
- Repair C-5-50 gate
- Stoner screen repair
- General maintenance

Details on the specific modification and maintenance work performed is provided in Section 3.2.

The product produced to date has been exceptionally close to the design basis from a chemical standpoint. The typical product analyses are shown in Section 4 of this report.

The Center SynCoal Project in Center, North Dakota, was officially closed down because of a lack of adequate financing.

The focus continues to be on operating the ACCP Demonstration plant to support testing and market development; serving nearby end users of the SynCoal<sup>®</sup> product and establishing more industrial customers; scheduling additional testburns and securing additional industrial contracts.

### **3.0 PROCESS DESCRIPTION**

In general, the ACCP is a thermal conversion process that uses combustion products and superheated steam as fluidizing gas in vibrating fluidized bed reactors. Two fluidized stages are used to thermally and chemically alter the coal, and one water spray stage followed by one fluidized stage is used to cool the coal. Other systems that service and assist the coal conversion system include:

- Coal Conversion;
- Coal Cleaning;
- Product Handling;
- Raw Coal Handling;
- Emission Control;
- Heat Plant;
- Heat Rejection; and
- Utility and Ancillary.

#### **3.1 ORIGINAL DESIGN PROCESS DESCRIPTION**

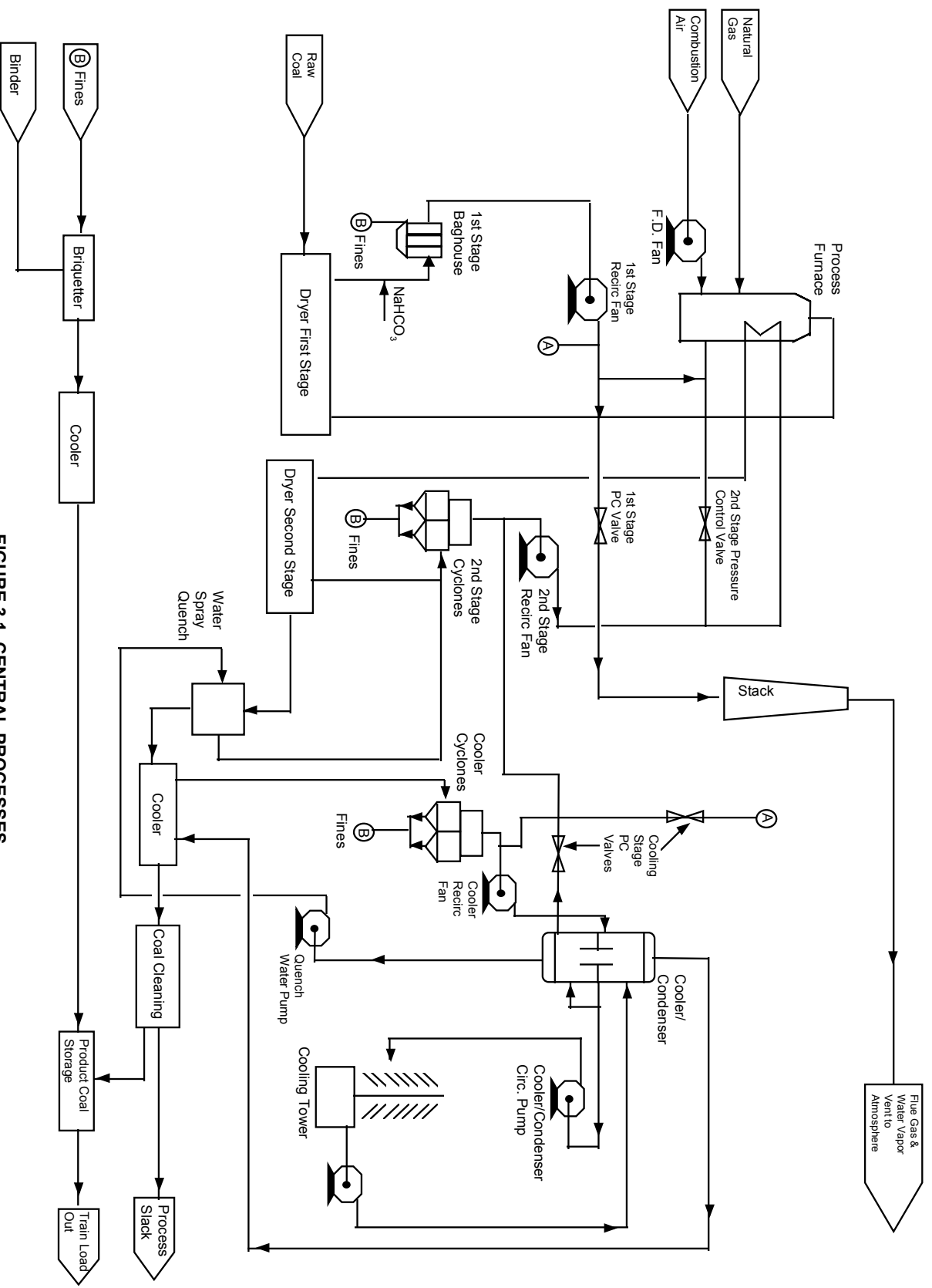
The designed central processes are depicted in Figure 3.1 on the following page. The following discusses plant design aspects and expected results. Modifications and operating results are summarized in Section 3.2.

##### **Coal Conversion**

The coal conversion is performed in two parallel processing trains. Each train consists of two, 5-foot-wide by 30-foot-long vibratory fluidized bed thermal reactors in series, followed by a water spray section, and a 5-foot-wide by 25-foot-long vibratory cooler. Each processing train is fed up to 1,139 pounds per minute of 2-by-½ inch coal.

In the first-stage dryer/reactors, the coal is heated by direct contact with hot combustion gases mixed with recirculated dryer makegas, removing primarily surface water from the coal. The coal exits the first-stage dryer/reactors at a temperature slightly above that required to evaporate water. After the coal exits the first-stage dryer/reactor, it is gravity fed to the second-stage thermal reactors, which further heats the coal using a recirculating gas stream, removing water trapped in the pore structure of the coal and promoting chemical dehydration, decarbonylation, and decarboxylation. The water, which makes up the superheated steam used in the second stage, is actually produced from the coal itself. Particle shrinkage that occurs in the second stage liberates ash minerals and passes on a unique cleaning characteristic to the coal.





MSE Drawing - Dated 11/8/92

FIGURE 3.1 CENTRAL PROCESSES

As the coal exits the second-stage thermal reactors, it falls through vertical quench coolers where process water is sprayed onto the coal to reduce the temperature. The water vaporized during this operation is drawn back into the second-stage thermal reactors. After water quenching, the coal enters the vibratory coolers where the coal is contacted by cool inert gas. The coal exits the vibratory cooler(s) at less than 150°F and enters the coal cleaning system. The gas that exits the vibratory coolers is dedusted in a twin cyclone and cooled by water sprays in direct contact coolers before returning to the vibratory coolers. Particulates are removed from the first-stage process gas by a pair of baghouses in parallel. The second-stage process gas is treated by a quad cyclone arrangement, and the cooler-stage process gas is treated by a twin cyclone arrangement.

Three interrelated recirculating gas streams are used in the coal conversion system; one each for the thermal reactor stages and one for the vibratory coolers.

Gases enter the process from either the natural gas-fired process furnace or from the coal itself. Combustion gases from the furnace are mixed with recirculated makegas in the first-stage dryer/reactors after indirectly exchanging some heat to the second-stage gas stream. The second-stage gas stream is composed mainly of superheated steam, which is heated by the furnace combustion gases in the heat exchanger. The cooler gas stream is made up of cooled furnace combustion gases that have been routed through the cooler loop.

A gas route is available from the cooler gas loop to the second-stage thermal reactor loop to allow system inerting. Gas may also enter the first-stage dryer/reactor loop from the second-stage loop (termed makegas) but without directly entering the first-stage dryer/reactor loop; rather, the makegas is used as an additional fuel source in the process furnace. The second-stage makegas contains various hydrocarbon gases that result from the thermal conversions associated with the mild pyrolysis and devolatilization. The final gas route follows the exhaust stream from the first-stage loop to the atmosphere.

Gas exchange from one loop to another is governed by pressure control on each loop, and after startup, will be minimal from the first-stage loop to the cooler loop and from the cooler loop to the second-stage loop. Gas exchange from the second-stage loop to first-stage loop (through the process furnace) may be substantial since the water vapor and hydrocarbons driven from the coal in the second-stage thermal reactors must leave the loop to maintain a steady state.

In each gas loop, particulate collection devices that remove dust from the gas streams protect the fans and, in the case of the first-stage baghouses, prevent any fugitive particulate discharge. Particulates are removed from the first-stage process gas by a pair of baghouses in parallel. The second-stage process gas is treated by a quad cyclone arrangement, and the cooler-stage process gas is treated by a twin cyclone arrangement.

## **Coal Cleaning**

The coal entering the cleaning system is screened into four size fractions: plus ½ inch, ½ by ¼ inch, ¼ inch by 8 mesh, and minus 8 mesh. These streams are fed in parallel to four, deep-bed stratifiers (stoners) where a rough specific gravity separation is made using fluidizing air and a vibratory conveying action. The light streams from the stoners are sent to the product conveyor, and the heavy streams from all but the minus 8 mesh stream are sent to fluidized bed separators. The heavy fraction of the minus 8 mesh stream goes directly to the waste conveyor. The fluidized bed separators, again using air and vibration to effect a gravity separation, each split the coal into light and heavy fractions. The light stream is considered product, and the heavy or waste stream is sent to a 300-ton, storage bin to await transport to an off-site user or alternately back to a mined out pit disposal site. The converted, cooled, and cleaned SynCoal® product from coal cleaning enters the product handling system.

## **Product Handling**

Product handling consists of the equipment necessary to convey the clean, granular SynCoal® product into two, 6,000-ton, concrete silos and to allow train loading with the existing loadout system. Additionally, the SynCoal® fines collected in the various stage particulate collection systems are combined, cooled, and transferred to a 300-ton storage silo designed for truck loadout to make an alternative product.

## **Raw Coal Handling**

Raw coal from the existing stockpile is screened to provide 1½ by-¾ inch feed for the ACCP process. Coal rejected by the screening operation is conveyed back to the active stockpile. Properly sized coal is conveyed to a 1000-ton, raw coal, storage bin which feeds the process facility.

## **Emission Control**

Sulfur dioxide emission control philosophy is based on injecting dry sorbents into the ductwork to minimize the release of sulfur dioxide to the atmosphere. Sorbents, such as trona or sodium bicarbonate, are injected into the first-stage gas stream as it leaves the first-stage dryer/reactors to maximize the potential for sulfur dioxide removal while minimizing reagent usage. The sorbents, having reacted with sulfur dioxide, are removed from the gas streams in the particulate removal systems. A 60-percent reduction in sulfur dioxide emissions should be realized.

The coal cleaning area fugitive dust is controlled by placing hoods over the sources of fugitive dust conveying the dust laden air to fabric filter(s). The bag filters can remove 99.99 percent of the coal dust from the air before discharge. All SynCoal<sup>®</sup> fines will report to the fines handling system and ultimately the SynCoal<sup>®</sup> fines stream.

### **Heat Plant**

The heat required to process the coal is provided by a natural gas-fired process furnace, which uses process makegas from the second-stage coal conversion as a supplemental fuel. This system is sized to provide a heat release rate of 74 MM Btu/hr. Process gas enters the furnace and is heated by radiation and convection from the burning fuel.

### **Heat Rejection**

Most heat rejection from the ACCP is accomplished by releasing water and flue gas into the atmosphere through an exhaust stack. The stack design allows for vapor release at an elevation great enough that, when coupled with the vertical velocity resulting from a forced draft fan, dissipation of the gases will be maximized. Heat removed from the coal in the coolers is rejected using an atmospheric-induced, draft cooling tower.

### **Utility and Ancillary Systems**

The coal fines that are collected in the conversion, cleaning, and material handling systems are gathered and conveyed to a surge bin. The coal fines are then agglomerated and returned to the product stream.

Inert gas is drawn off the cooler loop for other uses. This gas, primarily nitrogen and carbon dioxide, is used for inert purge gas and baghouses bag cleaning (pulsing) in the process. The makeup gas to the cooler loop is combustion flue gas from the stack. The cooling system effectively dehumidifies and cools the stack gas making the inert gas for the system. The cooler gas still has a relatively high dew point (about 90°F). Due to the thermal load this puts on the cooling system, no additional inert gas requirements can be met by this approach.

The common facilities for the ACCP Demonstration include a plant and instrument air system, a fire protection system, and a fuel gas distribution system.

The power distribution system includes a 15 kV service; a 15 kV/5 kV transformer; a 5 kV motor control center; two, 5 kV/480 V transformers; a 480 V load distribution center; and a 480 V motor control center.

The process is semi-automated, including dual control stations, dual programmable logic controllers, and distributed plant control and data acquisition hardware. Operator interface is necessary to set basic system parameters, and the control system adjusts to changes in the process measurements.

### **3.1.1 ORIGINAL EQUIPMENT**

The originally designed and installed major equipment for the ACCP Demonstration Facility is shown in Table 3.1 on the following page.

Table 3.1. Advanced Coal Conversion Process Major Plant Equipment - As Constructed

<b>System Description</b>	<b>Equipment Vendor</b>	<b>Type</b>
Thermal Coal Reactors/Coolers	Carrier Vibrating Equipment, Inc.	PE
Belt Conveyors	Willis & Paul Group	MH
Bucket Elevators	FMC Corporation	MH
Coal Cleaning Equipment	Triple S Dynamics, Inc.	CC
Coal Screens	Hewitt Robbins Corporation	MH
Loading Spouts	Midwest International	MH
Dust Agglomerator	Royal Oak Enterprises, Inc.	DH
Silo Mass Flow Gates	SEI Engineers, Inc.	MH
Vibrating Bin Dischargers	Carman Industries, Inc.	MH
Vibrating Feeder	Kinergy Corporation	MH
Drag Conveyor	Dynamet	DH
Process Gas Heater	G.C. Broach Company	PE
Direct Contact Cooler	CMI-Schneible Company	PE
Particulate Removal System	Air-Cure Howden	EC
Dust Collectors	Air Cure Environmental, Inc.	EC
Air Compressors/Dryers	Colorado Compressor, Inc.	CF
Diesel Fire Pumps	Peerless Pump Company	CF
Forced Draft Fans	Buffalo Forge Company	PE
Pumps	Dresser Pump Division Dresser Industries, Inc.	PE
Electrical Equipment-4160	Toshiba/Houston International Corporation	CF
Electrical Equipment-LDC	Powell Electric Manufacturing Company	CF
Electrical Equipment-480v MCC	Siemens Energy & Automation, Inc.	CF
Main Transformer	ABB Power T&D Company	CF
Control Panels	Utility Control & Equipment Corporation	CF
Control Valves	Applied Control Equipment	CF
Plant Control System	General Electric Supply Company	CF
Cooling Tower	The Marley Cooling Tower Company	PE
Dampers	Effox, Inc.	PE
Dry Sorbent Injec. System	Natech Resources, Inc.	EC
Expansion Joints	Flexonics, Inc.	PE
MH - Materials Handling PE - Process Equipment EC - Emissions Control CF - Common Facilities CC - Coal Cleaning DH - Dust Handling		

### **3.2 AS-BUILT PROCESS DESCRIPTION**

The ACCP facility has been modified as necessary during start-up and operation of the ACCP Demonstration Project. Equipment has been improved; additional equipment installed; and new systems designed, installed, and operated to improve the overall plant performance. Those adjustments are listed below and on the following pages.

#### **Coal Conversion System**

In 1992, several modifications were made to the vibratory fluidized bed reactors and processing trains to improve plant performance. An internal process gas bypass was eliminated, and the seams were welded out to reduce system leaks. Also, the reactor bed deck holes were bored out in both the first-stage dryer/reactor and the vibratory coolers to increase process gas flow.

The originally designed, two-train, fines conveying system could not keep up with the fines production. To operate closer to design conditions on the thermal coal reactors and coolers, obtain tighter control over operating conditions, and minimize product dustiness, the ACCP plant was converted to single train operation to reduce the overall fines loading prior to modifying the fines handling system during the outage of the summer 1993. One of the two process trains was removed from service by physically welding plates inside all common ducts at the point of divergence between the two process trains. This forced process gases to flow only through the one open operating process train.

In addition to the process train removal, the processed fines conveying equipment was simultaneously modified to reduce required throughput on drag conveyors. This was accomplished by adding a first-stage screw conveyor and straightening and shortening the tubular drag conveyors.

The ACCP design included a briquetter for agglomeration of the process fines. However, initial shakedown of the plant required the briquetting system be completely operational. Since the briquetting operation was delayed to focus on successfully operating the plant, the process design changes included fines disposal by slurring them to an existing pit in the mine. During 1992, a temporary fines slurry disposal system was installed. The redesigned process fines conveying and handling system was commissioned. Design of a replacement fines conveying system is now complete and delivering to a truck loadout slurry or briquetter.

The main rotary airlocks were required to shear the pyrite and "bone" or rock that is interspersed with the coal; however, the design of the rotary airlocks was insufficient to convey this non-coal material. Therefore, the drive motors were retrofitted from 2 to 5 horse power for all eight process rotary airlocks. Also, an

electrical current sensing circuit that reverses the rotary lock rotation was designed, tested, and applied to the rotary airlocks. This circuitry is able to sense a rotor stall and reverse the motor to clear the obstruction before tripping the motor circuit breaker.

Due to the occasional receipt of wet sticky feed coal, the rotors were modified from eight pocket to four pocket by removing every other blade.

The original plant startup tests also revealed explosion vent discrepancies in all areas, thus preventing extended operation of the plant. The design development for the vents was a cooperative effort between an explosion vent manufacturing company and the ACCP personnel and resulted in a unique explosion vent sealing system which was completed during 1993. The new explosion vent design was implemented during 1993 and has been performing well since.

The vibratory fluid bed reactors suffered from stress cracking in the base on two occasions. The first cracking occurred approximately November, 1992. A combination of dynamic and thermal stresses caused the vibratory drives of the dryers to begin cracking their structural welds where they connect to the dryer plenum. This problem was mitigated by reducing the thermal stresses on the welds by insulating the inside of the plenum and removing the insulation from the weld areas on the outside of the dryers.

The second set of cracking problems were somewhat a result of the solution to the first set of cracking problems. Again on the plenum bottom, cracking occurred adjacent to the vibratory drives. This time the cracks were not necessarily in the vibratory drive structural welds, instead they began and propagated through the parent steel of the plenum. A specimen of the failed steel was removed and sent to a metallurgist for failure root cause analysis. The metallurgist reported the failure was caused by stress corrosion cracking (SCC). The insulation installed on the inside of the plenum had caused the parent steel temperature to fall into the chlorine ion attack range and the insulation had supplied enough chlorine to cause the SCC. Mitigation of the second cracking problem is planned for mid to late 1996. New parent steel will be installed inside the plenum, along with a sacrificial aluminum sheet and chlorine free insulation.

In 1992, 1993, and 1994 the ACCP facility experienced chronic failure of fan bearings on the first stage and cooler circulating gas fans. A primary failure mode was never identified but the failures were attributed to a combination of too low of loads on the original roller bearings, contamination of the bearing lube oil, and heat loads on the bearings by conduction through the fan shafts. The original bearings were oil lubricated with a small oil reservoir internal to the bearing.

In the second quarter of 1995, a lubricating oil system was installed for the first stage and cooler fans along with new bearings to accept a forced lubrication system. The lube oil systems included lube oil temperature control, filtering, and flow controls. Bearing failure has essentially been eliminated.



## **Coal Cleaning**

The coal entering the cleaning system is screened into four size fractions: plus ½ inch, ½ by ¼ inch, ¼ inch by 8 mesh, and minus 8 mesh. These streams are fed in parallel to four, deep-bed stratifiers (stoners) where a rough, specific gravity separation is made using fluidizing air and a vibratory conveying action. The light streams from the stoners are sent to the product conveyor, and the heavy streams from all but the minus 8 mesh stream are sent to fluidized bed separators. The heavy fraction of the minus 8 mesh stream goes directly to the waste conveyor. The fluidized bed separators, again using air and vibration to effect a gravity separation, each split the coal into light and heavy fractions. The light stream is considered product, and the heavy or waste stream is sent to a 300-ton, storage bin to await transport back to the mined out pit disposal site. The dried, cooled, and cleaned product from coal cleaning enters the product handling system. Modifications were made in 1992 that allows product to be sent to the waste bin with minimal reconfiguration.

## **Product Handling**

Work is continuing on testing and evaluating technologies to enhance product stabilization and reduce fugitive dustiness. During 1992, a liquid carbon dioxide storage and vaporization system was installed for testing product stability and providing inert gas for storage and plant startup/shutdown. During the Fourth Quarter of 1994, an additional inert gas system was installed.

The clean product coal is conveyed into two, 5,000-ton capacity, concrete silos which allow train loading with the existing loadout system. The silo capacity was reduced from the 6,000 ton design to approximately 5,000 actual tons due to the relatively low SynCoal<sup>®</sup> density.

Automatic Sampler - During the first quarter of 1995 an automatic sampler was installed on belt C-9-8 to obtain representative daily production samples.

Truck Loadout System - Due to an increasing truck sales volume, a truck loadout system was designed and the construction was completed in October 1995. Previously, trucks were loaded through the existing train loadout tipple. The previously existing tipple system was not adequate for large truck volumes due to long load times, inaccurate loading, excessive labor charges, and interference with train loading. The new truck loadout system includes handling equipment to transfer SynCoal<sup>®</sup> to a new 70 ton truck loadout bin from the 5,000 ton T9-95 silo and a weighing system for accurately loading trucks.

Gate Modifications to T-95 and T-96 Silo – Since startup of the ACCP, the spontaneous combustion nature of SynCoal<sup>®</sup> requires storage of the product in inert gas or tightly sealed vessels to prevent air infiltration. The CO<sub>2</sub> inerting

system was developed for silo storage of the SynCoal<sup>®</sup> product and later the inert gas system was installed.

The as-built silo gates were 48"x48", designed to allow about 5,000 TPH of raw sticky coal to flow to the C-12 conveyor. SynCoal<sup>®</sup> flows more easily than raw coal and as such, the gates were substantially oversized. The gates were designed with large moving clearances. These "gaps" allowed either infiltration of air or significant leakage of CO<sub>2</sub>. Efforts in the past to tighten the clearances and reduce the gaps did not solve the problem of lost CO<sub>2</sub>.

During the first quarter of 1997, the six original 48"x48" gates and the two center mass flow gates, along with the attendant chutes were replaced with four 15"x15" gates on the silos and two 24"x24" gates, one in the center of each silo.

### **Raw Coal Handling**

Raw coal from the existing stockpile is screened to provide 1¼-by-½ inch feed for the ACCP process. Coal rejected by the screening operation is conveyed back to the active stockpile. Properly sized coal is conveyed to a 1,000-ton, raw coal, storage bin which feeds the process facility.

### **Emission Control**

It was originally assumed that sulfur dioxide emissions would have to be controlled by injecting chemical sorbents into the ductwork. Preliminary data indicated that the addition of chemical injection sorbent would not be necessary to control sulfur dioxide emissions under the operating conditions. A mass spectrometer was installed to monitor emissions and process chemistry; however, the injection system is in place should a higher sulfur coal be processed or if process modifications are made and sulfur dioxide emissions need to be reduced.

The coal-cleaning area's fugitive dust is controlled by placing hoods over the fugitive dust sources conveying the dust laden air to fabric filter(s). The bag filters appear to be effectively removing coal dust from the air before discharge. The Department of Health and Environmental Sciences completed stack tests on the east and west baghouse outlet ducts and the first-stage drying gas baghouse stack in 1993. The emission rates of 0.0013 and 0.0027 (limit units of 0.018 grains/dry standard cubic feet) (gr/dscf) and 0.015 gr/dscf (limit of 0.031), respectively, are well within the limits stated in the air quality permit.

A stack emissions survey was conducted in May 1994. The survey determined the emissions of particulates, sulfur dioxide, oxides of nitrogen, carbon monoxide, total hydrocarbons, and hydrogen sulfide from the coal dryer stack. The principal conclusions based on averages are:

- The emissions of particulate matter from the dryer stack were 0.0259 gr/dscf (2.563 pounds per hour). (Limit: 0.031 gr/dscf.)
- The emissions of nitrogen oxides were 4.50 pounds per hour (54.5 parts per million). (Limit: 7.95 lb/hr estimated controlled emissions, and 11.55 lb/hr estimated uncontrolled emissions based on vendor information.)
- The emissions of carbon monoxide were 9.61 pounds per hour (191.5 parts per million). (Limit: 6.46 lb/hr estimated controlled emissions, and 27.19 lb/hr estimated uncontrolled emissions based on vendor information.)
- The emissions of total hydrocarbons as propane (less methane and ethane) were 2.93 pounds per hour (37.1 parts per million).
- The emissions of sulfur dioxide were 0.227 pounds per hour (2.0 parts per million). (Limit: 7.95 lb/hr estimated controlled emissions, and 20.27 lb/hr estimated uncontrolled emissions for sulfur oxides.)
- The emissions of hydrogen sulfide were 0.007 pounds per hour (0.12 parts per million).

### **Process Gas Heater**

The heat required to process the coal is provided by a natural gas-fired process furnace, which uses process makegas from coal conversion as fuel. The vibration problems and conversion system problems discussed previously initiated removing and redesigning the process gas fans shaft seals to limit oxygen infiltration into the process gas. This system provides a maximum heat release rate of up to 74 MM Btu/hr depending on the feed rate.

In 1995, several modifications were made to the process gas heater. Significant damage had occurred to the old heat exchanger from high temperature creep and embrittlement. Half of the process gas heat exchanger was replaced with modules made of a higher quality stainless steel.

Two additional modifications were made to help protect and enhance the performance of the heat exchanger. A soot blower was installed to keep the heat exchanger from fouling and refractory brick baffles were added to block radiative heat from the heat exchanger face.

### **Heat Rejection**

Heat removed from the coal in the coolers is rejected indirectly through cooling water circulation using an atmospheric-induced, draft-cooling tower. A substantial amount of the heat added to the system is actually lost by releasing water vapor

and flue gas into the atmosphere through an exhaust stack. The stack allows for vapor release at an elevation great enough that, when coupled with the vertical velocity resulting from a forced draft fan, maximized dissipation of the gases. The evaluation from 1993 indicated the cooling tower limitation issues could be resolved by providing additional makeup water to the system. A 2-inch valve was installed on the cooling water line to the cooling tower to provide the necessary makeup water.

### **Utility and Ancillary Systems**

The fines handling system consolidates the coal fines that are produced in the conversion, cleaning, and material handling systems. The fines are gathered by screw conveyors and transported by drag conveyors to a bulk cooling system. The cooled fines are stored in a 250-ton capacity bin until loaded into pneumatic trucks for off-site sales.

When off-site sales lag production, the fines are mixed with water in a specially designed tank and slurried back to the mine pit.

An inert gas system cools, dehumidifies and compresses stack gas. The inert gas, which contains mainly nitrogen and carbon dioxide, is used by the first-stage baghouse cleaning blowers and is also used as a blanket gas in the product and fines storage silos. The makeup gas to the cooler loop is combustion flue gas from the stack. The cooling system effectively dehumidifies and cools the stack gas making the inert gas for the system. The cooler gas still has a relatively high dew point (about 90°F). Due to the thermal load this puts on the cooling system, no additional inert gas requirements can be met by this approach, therefore a new inert gas system was required (see description below).

The common facilities for the ACCP include a plant and instrument air system, a fire protection system, and a fuel gas distribution system.

The power distribution system was upgraded by installing an uninterruptible power supply (UPS) during 1993. The UPS system does not keep the plant running if there is a problem; however, it does keep the control system, emergency systems, and office lights operating.

The process is semi-automated including dual control stations, dual programmable logic controllers, and distributed plant control and data acquisition hardware. Graphic interface programs are continually being modified and upgraded to improve the operator interface and provide more reliable information to the operators and engineers.

### **Inert Gas System Description**

The Inert Gas System (IGS) was designed to compress stack gas at the ACCP, mainly for the purpose of SynCoal<sup>®</sup> product storage inerting. A complete report on the IGS design and operation has been completed.

The IGS is comprised of a stack connection (take-off), gas cooling heat exchanger, water knock-out drum, particulate removal, compressor, compressed gas desiccant dryer, gas receiver, and distribution piping.

The IGS starts at the ACCP plant stack and is connected via an 18" diameter pipe. A hand valve is used to operate the inert gas into the main process heat exchanger (X-2-60).

The process heat exchanger is a two-cell fin-tube exchanger, 30 feet long and 12 feet wide with approximately 81,850 ft<sup>2</sup> of heat exchange surface area. The heat exchanger was designed and manufactured in May 1994 by Ambassador Heat Transfer Company, and was designated Model Number PCS-315. Two fans are driven each by a 30 HP variable frequency drive (VFD) based on process temperature of the gas exiting the exchanger. The exchanger was designed to cool a wet gas stream, 1506 SCFM (dry basis) from 270°F to approximately 100°F. The temperature of the inert gas is designed to be no higher than 115°F.

The inert gas, after cooling, passes through a knock-out (KO) drum (T-2-59) complete with mist eliminator (demister pad) packing. Water droplets and liquid condensate are contained in the lower portion of the KO drum which allows storage of the liquid and delivery to pump (P-2-62) delivering the condensate liquid to the slurry system.

Dry Inert Gas proceeds to either the IGS compressor or the ACCP first stage PRS baghouse blowers.

There are two particulate filtration systems for the inert gas prior to compression. The first particulate filter (D-2-66) is located above the IGS skid and consists of parallel filter canisters, Solberg Model CSL-485P (2)-1200F. The elements are designed to remove 5 micron particulate. The second particulate filter (D-2-67) is located at the inlet to the compressor, and consists of two Stoddard F65V-6 canisters in parallel, complete with bypass valving. The elements used are Stoddard F64-6, 99% efficient at 1 micron particulate removal.

The inert compressor skid system (J-2-63) is a self contained package supplied by Energy Equipment and Supply of Casper, Wyoming and is comprised mainly of LeROI components. The inlet gas first flows through an inlet scrubber to remove any remaining moisture prior to the compressor. The compressor is a G series LeROI oil flooded single screw compressor (Model No. 2A219-131) with a 200 HP, 4160V motor. Approximately 983 ICFM (actual cubic feet per minute at the compressor inlet) of inert gas flows into the screw compressor along with lubricating oil returning from the air/oil separator sump. The compressed gas flows to the air/oil separator, where the oil disengages the compressed gas.

Approximately 703 SCFM of compressed inert gas is kept at 100 psig as it passes through the Kimray regulator prior to gas cooling. The gas and the oil are cooled through individual sections of a Fin-X, Incorporated fin-fan heat exchanger with air actuated shutters. A 5 HP fan supplies the cooling air through the heat exchanger. After cooling, the gas passes through a final moisture separator which discharges to the floor drain.

After the compressor moisture separator, the compressed gas proceeds to the regenerative desiccant drying system. The inert gas regenerative desiccant drying system (R-2-65) is supplied by Pioneer Air Systems Incorporated. The unit consists of twin Pioneer PHE-1000 desiccant towers. One unit is always in service, while the other tower is in the drying mode. The PHE dryer is equipped with an external heater to aid in drying the desiccant. The unit is supplied with pre and post coalescing filters to eliminate the carry over of droplets and mists of both liquid water and compressor lubricant, as well as particulate from the regenerative drying system.

After the regenerative desiccant dryer system, the inert gas is stored in a 400 gallon receiver tank (T-2-58). The inert gas is controlled and distributed through the distribution manifold system located at the North end of the ACCP plant. This distribution manifold incorporates oxygen measurement and control such that if the inert gas oxygen content is higher than allowed, a valve shuts stopping the inert gas from flowing to the point of end-use.

The inert gas pressure is provided at 80 psig (high pressure) and controlled at 25 psig prior to the low pressure distribution for either the plant location or the silo. The inert gas is available to the soot blowers and the infeed rotary air-locks at system pressure of 80 psig. After the 25 psig control point at the regulator, low pressure inert gas is available for purging at the second stage reactor deck located centrally to the plant, or to the silo.

Each silo has five locations with 2" diameter piping for inerting:

1. The No. 1 silo pipe feeding the top ring consisting of 16 each  $\frac{3}{4}$ " pipe penetrations located at 10 foot from the top of the silo.
2. The No. 2 silo pipe feeding the top ring consisting of 16 each  $\frac{3}{4}$ " pipe penetrations located at 35 foot from the top of the silo.
3. The No. 3 silo pipe feeding the hoppers (three each per silo).
4. The No. 4 silo pipe feeding the mid-point of the silo on the south side, and
5. The No. 5 silo pipe feeding the mid-point of the silo on the north side.

On top of the silo, Line Location No. 2 has valving to supply either the 35 foot ring (No. 2B), or distribution to the very top of the silo (No. 2A).

### **3.2.1 MODIFIED OR REPLACED EQUIPMENT**

Facility modifications and maintenance work to date have been dedicated to obtaining an operational facility.

The modifications to the original system performed for this quarter are listed below.

## **SECOND QUARTER**

### **Process Fines Handling**

- Repair broken belt on C-0-26 drag conveyor
- Repair broken chain on C-0-26 drag conveyor
- Relocate slurry pump P-O-10
- Repair C-0-28 chain
- Repair P-0-8 pump

### **Process Furnace**

- Replace refractory in furnace

### **Coal Cleaning System**

- Repair C-5-50 gate
- Stoner screen repair

### **General Maintenance**

## **FIRST QUARTER**

### **Coal Conversion System**

- Replace bearing in the 1000 horsepower K-55 fan
- Welded major structural crack in dryer bed R-51
- Replace R51 dryer timing sheave and belts
- Repair weir on R-5-51
- Repair drive belts on R-5-51
- Repair coupler sleeve on L-5-19

### **Process Fines Handling**

- Replace impeller on pump P-0-08
- Repair bearing on C-0-18 dust auger
- Replace sprocket on C-0-26 drag conveyor
- Repair drag chain C-0-26

### **Process Furnace**

- Replace controller in furnace

### **Miscellaneous repairs/maintenance caused by cold weather**

Table 3.2 shows the equipment that has either been modified or replaced from plant startup. If replacement was required, the new equipment is listed.



Table 3.2. Advanced Coal Conversion Process Modified Major Plant Equipment

System Description	Equipment Vendor	Type	Modified No/Yes	Replaced With
Thermal Coal Reactors/Coolers	Carrier Vibrating Equipment, Inc.	PE	/	
Belt Conveyors Product Sampler	Willis & Paul Group Inner Systems	MH MH	/ Added	
Bucket Elevators	FMC Corporation	MH	/	
Coal Cleaning Equipment	Triple S Dynamics, Inc.	CC	/	
Coal Screens	Hewitt Robbins Corporation	MH	/	
Loading Spouts	Midwest International	MH	/	
Dust Agglomerator	Royal Oak Enterprises, Inc.	DH	/	
Silo Mass Flow Gates	SEI Engineers, Inc.	MH	/	Custom Fabricated
Vibrating Bin Dischargers	Carman Industries, Inc.	MH	/	
Vibrating Feeder	Kinergy Corporation	MH	/	
Drag Conveyor	Dynamet	DH	/	PFHS
Screw Conveyor	Farm Aid Equipment Company	MH	Added	PFHS
Processed Fines Handling Sys. Bucket Elevators Screw Conveyors Drag Conveyors Processed Fines Cooler Slurry Tank Agitator Slurry Tank Slurry and Pit Pumps Processed Fines Load Out Bin	Continental Screw Conveyor Corp. Continental Screw Conveyor Corp. AshTech Corporation Cominco Engineering Services, Ltd. Chemineer, Inc. Empire Steel Manufacturing Co. Goulds Pumps/Able Technical P & S Fabricators	DH DH DH DH DH DH DH DH	Added Added Added Added Added Added Added Added	
Process Gas Heater	G.C. Broach Company	PE	/	
Direct Contact Cooler	CMI-Schneible Company	PE	/	
Particulate Removal System	Air-Cure Howden	EC	/	
Dust Collectors	Air Cure Environmental	EC	/	
Air Compressors/Dryers	Colorado Compressor, Inc.	CF	/	
Diesel Fire Pumps	Peerless Pump Company	CF	/	
Forced Draft Fans	Buffalo Forge Company	PE	/	
Pumps	Dresser Pump Division Dresser Industries, Inc.	PE	/	
Electrical Equipment-4160	Toshiba/Houston International Corp.	CF	/	
Electrical Equipment-LDC	Powell Electric Manufacturing Corp.	CF	/	
Electrical Equipment-480v MCC	Siemens Energy & Automation, Inc.	CF	/	
Uninterruptible Power Supply	Best Power Technologies Company	CF	Added	

Table 3.2. Advanced Coal Conversion Process Modified Major Plant Equipment (cont'd.)

Main Transformer	ABB Power T&D Company	CF	/	
Control Panels	Utility Control & Equipment Corp.	CF	/	
Control Valves	Applied Control Equipment	CF	/	
Plant Control Systems	General Electric Supply Company	CF	/	
Cooling Tower	The Marley Cooling Tower Company	PE	/	
Dampers	Effox, Inc.	PE	/	
Dry Sorbent Injec. System	Natech Resources, Inc.	EC	/	
Expansion Joints	Flexonics, Inc.	PE	/	
Truck Loadout System Truck Silo Steel Silo Gate & Discharge Spout Bin Weigh Scales Bucket Elevator Erection	Wm. Kronmiller Midwest International Kissler Morris Power Transmission & Equipment Cop Construction / L.H. Sowles / SageBrush	MH	Added	
Inert Gas System Air Cooled Heat Exchanger Inert Gas Compressor Inlet Filter Knock-Out Drum Regenerative Desiccant Dryers Erection	Ambassador Heat Transfer LeROI/Energy Equipment & Supply Air-Cure Environmental Ambassador Heat Transfer Pioneer/Industrial Tool & Supply Sagebrush/L.H. Sowles	CF	Added	
MH - Materials Handling PE - Process Equipment EC - Emissions Control CF - Common Facilities CC - Coal Cleaning DH - Dust Handling				

## 4.0 TECHNICAL PROGRESS

### 4.1 SYNCOAL® SALES/SHIPMENTS

Table 4.1 lists the customers by category and the sales for the 2<sup>nd</sup> Quarter of 1997 as well as the year to date sales.

**Table 4.1 SynCoal® Sales  
2<sup>nd</sup> Quarter**

Customer Type/ Name	SynCoal Product	Total 1 <sup>st</sup> Qtr	April Sales	May Sales	June Sales	Total 2 <sup>nd</sup> Qtr	Year to Date
<b>INDUSTRIAL</b>							
Ash Grove Cement	Regular	9,330	3,735	3,275	3,503	10,513	19,843
Bentonite Corporation	Regular	2,396	1,058	1,344	994	3,396	5,792
Bentonite Corporation	Blend	0	0	0	154	154	154
Wyoming Lime	Regular	3,311	782	1,213	1,172	3,167	6,477
Empire Sand & Gravel	Regular	37	72	508	329	910	946
Pete Lien	Regular	0	0	142	1,038	1,180	1,180
<b>UTILITY</b>							
Colstrip Units 1&2	Wet	44,903	15,193	17,571	20,412	53,176	98,079
Colstrip Units 1 & 2	Dry		75				
<b>TOTAL TONS SOLD</b>		59,976	20,915	24,054	27,601	72,570	132,546

## 4.2 FACILITY OPERATIONS/PLANT PRODUCTION

Table 4.2 summarizes the ACCP Demonstration Facility's operations and plant production levels that have been achieved throughout this reporting period and the facility's lifetime to date.

The following calculations were used in Table 4.2:

- Period Hours = Days in Reporting Period x 24 Hours/Day
- Availability Rate = Operating Hours/Period Hours x 100
- Average Feed Rate = Tons Fed/Operating Hours
- Monthly Capacity Factor = Tons Processed/Rated Design Capacity (1232.88 tons/day)
- Forced Outage Rate = Forced Outage Hours/(Forced Outage Hours + Operating Hours) x 100

The difference between the feed coal and the amount of clean coal produced is due to water loss; samples removed for analysis; and processed fines, which are captured in the dust handling system and returned to the mine for disposal. Very little dust is actually lost to the atmosphere.

**Table 4.2 ACCP Demonstration Project 1997 Monthly Operating Statistics\***

Month	Operating Hours	Availability Rate	Planned Maint. Hours	Forced Outage Hours	Forced Outage Rate	Feed Tons	Ave. Feed Rate	Feed Capacity Factor	Total Shipments	Ending Silo Inventory
Jan. '97	330	44%	0	414	56%	22,029	66.8	58%	10,601	3,811
Feb. '97	478	71%	0	194	29%	31,995	66.9	89%	21,941	1,655
Mar '97	630	85%	0	114	15%	42,904	68.1	112%	27,434	1,270
1st Qtr Summary	1,438	66.57%	0	722	33%	96,928	67.4	87%	59,976	
Apr '97	539	75%	0	182	25%	36,351	67.6	95%	20,915	1,270
May '97	567	76%	0	177	24%	39,150	69.0	102%	24,054	3,990
June '97	605	84%	13	102	14%	41,910	69.3	110%	27,601	3,053
2 <sup>nd</sup> Qtr Summary	1,710	79%	13	461	21%	117,411	68.7	106%	72,570	
<b>1997 YTD Summary</b>	<b>3,148</b>		<b>0</b>			<b>214,339</b>	<b>68.1</b>		<b>132,546</b>	
<b>LTD Totals</b>	<b>27,224</b>		<b>9,543</b>			<b>1,621,990</b>	<b>59.6</b>		<b>956,640</b>	

\*An internal audit revealed discrepancies in some of the tonnages. The totals reported in this report reflect the actual numbers.

A general material and energy balance around the ACCP is shown in Figure 4.1 from testing conducted in May, 1994. The description is for the Rosebud coal that is normally tested and processed through the ACCP Demonstration Facility. An energy conversion of 87.1 percent is depicted. Loss of moisture up the stack accounts for the weight difference of input versus output.

Figure 4.1. General Material and Energy Balance

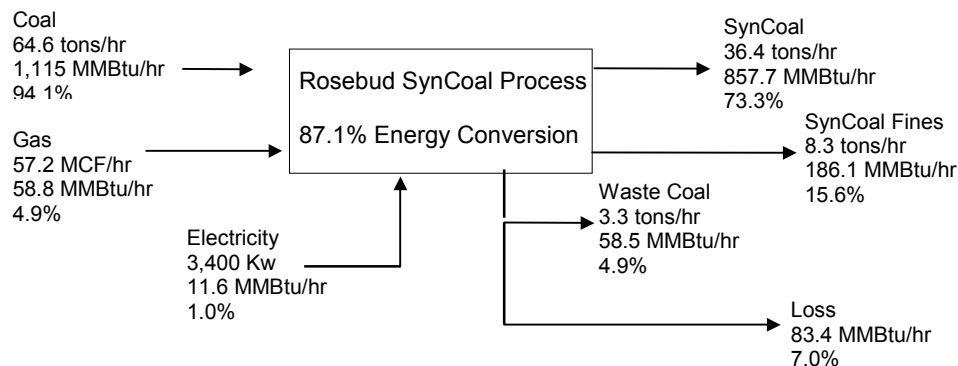


Table 4.3 provides mass and energy balance information for the second quarter of 1997. This information is based upon total quantities into and out of the demonstration process facility. The known weight loss is the water removed from the raw coal. The unknown weight loss is all the other losses not measured. All energy losses are identified as unknown. The total average this year was 83.8% of the energy input converted to salable product. Figure 4.2 depicts this information in a more graphic form.

Figure 4.2 Yearly Summary of Material and Energy Balance

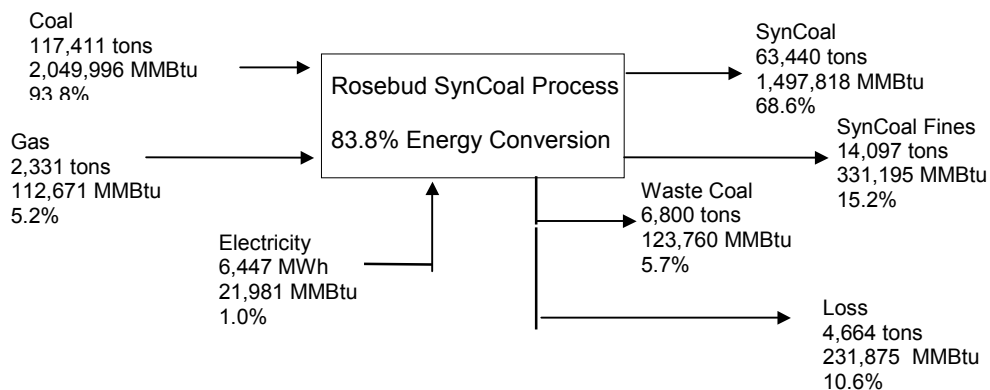


Table 4.3 Mass and Energy

<b>2<sup>nd</sup> Quarter</b>	<b>INPUT</b>			<b>OUTPUT</b>				
	Raw Coal Tons	Natural Gas Tons	Electricity MWh	SynCoal Tons	SynCoal Fines Tons	Waste Tons	Moisture Loss Tons	Unknown Loss Tons
AMOUNTS	<b>117,411</b>	<b>2,331</b>	<b>6,447</b>	<b>63,440</b>	<b>14,097</b>	<b>6,800</b>	<b>28,410</b>	<b>4,664</b>
%	<b>100%</b>			<b>54.0%</b>	<b>12.0%</b>	<b>5.8%</b>	<b>24.2%</b>	<b>8.0%</b>
MMBtu	<b>2,049,996</b>	<b>112,671</b>	<b>21,981</b>	<b>1,497,818</b>	<b>331,195</b>	<b>123,760</b>		<b>231,875</b>
%	<b>93.8%</b>	<b>5.2%</b>	<b>1.0%</b>	<b>68.6%</b>	<b>15.2%</b>	<b>5.7%</b>		<b>10.6%</b>
Btu/lb	<b>8,730</b>			<b>11,805</b>	<b>11,747</b>	<b>9,100</b>		
% Moisture	<b>25.85%</b>			<b>1.96%</b>	<b>3.85%</b>	<b>2.28%</b>		
% Ash	<b>8.52%</b>			<b>8.70%</b>	<b>10.16%</b>	<b>30.03%</b>		
<b>1<sup>st</sup> Quarter</b>	<b>INPUT</b>			<b>OUTPUT</b>				
	Raw Coal Tons	Natural Gas Tons	Electricity MWh	SynCoal Tons	SynCoal Fines Tons	Waste Tons	Moisture Loss Tons	Unknown Loss Tons
AMOUNTS	96,928	2,006	5,858	52,451	11,636	5,818	23,304	3,719
%	100%			54.1%	12.0%	6.0%	24.0%	8.0%
MMBtu	1,678,018	96,972	19,973	1,234,067	273,376	105,888		181,632
%	93.5%	5.4%	1.1%	68.8%	15.2%	5.9%		10.1%
Btu/lb	8,656			11,764	11,747	9,100		
% Moisture	25.61%			1.79%	3.85%	2.28%		
% Ash	8.98%			9.08%	10.16%	30.03%		

\* Waste coal and fines analysis for this quarter were based on 1996 statistics.

### **4.3 FACILITY TESTING**

The facility testing to date has focused on controlling spontaneous combustion of the cleaned coal product.

### **4.4 PRODUCT TESTING**

The product produced to date has been exceptionally close to the design basis product from a chemical standpoint but has not been acceptable from a physical standpoint due to instability (spontaneous heating) and dustiness. The typical product analyses are shown in Table 4.6.

The following tests were conducted during the second quarter of 1997.

- Ash yield tests were completed for Globe Metallurgical. Preliminary analysis results show two production test streams that are producing a product that may be acceptable.
- A coke/SynCoal<sup>®</sup> blend test was conducted with the following results:
  - a 75% SynCoal<sup>®</sup> / 25% coke smoked after 5 days
  - a 50% SynCoal<sup>®</sup> / 50% coke smoked after 11 days, 2 days later it stopped and remained stable
  - a 25% SynCoal<sup>®</sup> / 75% coke remained stable
- A DSE SynCoal<sup>®</sup> fines/coarse blend test was done to determine dustiness after being windrowed over a period of hours. The test proved favorable for handling this product for a period of 3-5 hours after being windrowed.
- Pete Lien & Sons report favorable results in their testing of coarse SynCoal<sup>®</sup>, but are experiencing dusty conditions in ground blending the SynCoal<sup>®</sup> and the raw coal. They are investigating the possibility installing a silo to store the SynCoal<sup>®</sup> and eliminate the ground blending. They anticipate their use of SynCoal<sup>®</sup> would be 14,000 per year.



Table 4.4 1997 2nd Quarter Raw Feed Coal Analyses

<b>MONTH</b>	<b>TONNAGE</b>	<b>MOISTURE %</b>	<b>ASH %</b>	<b>SULFUR %</b>	<b>BTU/LB</b>	<b>LBS SO2/ MMBTU</b>
January	22,029	26.74	8.86	0.78	8,616	1.81
February	31,995	25.48	8.97	0.82	8,646	1.90
March	42,904	25.13	9.06	0.79	8,684	1.82
1 <sup>st</sup> Qtr Avg.	32,309	25.61	8.98	0.80	8,656	1.84
<b>April</b>	<b>36,351</b>	<b>26.39</b>	<b>8.71</b>	<b>0.71</b>	<b>8,683</b>	<b>1.76</b>
<b>May</b>	<b>39,150</b>	<b>24.93</b>	<b>8.22</b>	<b>0.69</b>	<b>8,789</b>	<b>1.62</b>
<b>June</b>	<b>41,910</b>	<b>26.23</b>	<b>8.64</b>	<b>0.66</b>	<b>8,715</b>	<b>1.51</b>
<b>2nd Qtr Avg.</b>	<b>39,137</b>	<b>25.85</b>	<b>8.52</b>	<b>0.69</b>	<b>8,730</b>	<b>1.62</b>

Table 4.5 As-Produced Waste Coal Analyses

The ACCP plant did not sample any of the waste product produced. The quality analyses used in Figure 4.2 and Table 4.3 are based on averages taken in 1996.

Table 4.6 Product Analyses – 2<sup>nd</sup> Quarter

	Moist. %	Ash %	Sulfur %	Btu/lb	No. of Samples
<b><u>SYNCOAL PRODUCT AS-PRODUCED</u></b>					
<b><u>APRIL, 1997</u></b>					
Avg	1.73	8.83	0.7	11,825	9
Std	0.23	0.2	0.03	57	
Min	1.43	8.54	0.66	11,686	
Max	2.06	9.18	0.75	11,877	
<b><u>MAY, 1997</u></b>					
Avg	2.05	8.27	0.71	11,944	6
Std	0.37	0.27	0.06	239	
Min	1.49	7.98	0.63	11,812	
Max	2.56	8.61	0.77	12,427	
<b><u>JUNE, 1997</u></b>					
Avg	2.07	8.99	0.75	11,657	10
Std	0.81	0.59	0.07	173	
Min	1.21	7.93	0.66	11,352	
Max	4.21	10.01	0.85	11,844	
<b>2<sup>ND</sup> QUARTER AVERAGE</b>					
Avg	1.96	8.70	0.72	11,805	
Std	0.48	0.36	0.05	159.11	
Min	1.37	8.14	0.65	11,609	
Max	2.99	9.29	0.79	12,049	

Table 4.6 Product Analyses – 2<sup>ND</sup> Quarter (Continued)

**APRIL, 1997**

	<b>Moist. %</b>	<b>Ash %</b>	<b>Sulfur %</b>	<b>Btu/lb</b>	<b>No. of Samples</b>
<b><u>SYNCOAL PRODUCT SHIPMENTS TO CUSTOMERS</u></b>					
Ash Grove Cement Regular	1.85	9.24	0.68	11,780	7
Bentonite Corporation Regular	1.73	9.22	0.68	11,781	28
Wyoming Lime Regular	1.73	9.17	0.68	11,812	19
Pete Lien Regular	1.73	8.83	0.70	11,826	2
Empire Sand & Gravel Regular	1.49	9.05	0.66	11,728	1
Montana Power Units 1&2 DSE	18.97	8.18	0.58	9,571	12

Table 4.6 Product Analyses – 2<sup>nd</sup> Quarter (Continued)

**MAY, 1997**

	<b>Moist. %</b>	<b>Ash %</b>	<b>Sulfur %</b>	<b>Btu/lb</b>	<b>No. of Samples</b>
<b><u>SYNCOAL PRODUCT SHIPMENTS TO CUSTOMERS</u></b>					
Ash Grove Cement Regular	1.77	8.94	0.73	11,848	8
Bentonite Corporation Regular	1.57	8.98	0.70	11,871	19
Wyoming Lime Regular	1.70	9.13	0.71	11,862	30
Empire Sand & Gravel Regular	1.66	8.97	0.73	11,850	12
Montana Power Units 1&2 DSE	16.89	7.78	0.59	9,933	16

Table 4.6 Product Analyses – 2<sup>nd</sup> Quarter (Continued)

***JUNE, 1997***

	<b>Moist. %</b>	<b>Ash %</b>	<b>Sulfur %</b>	<b>Btu/lb</b>	<b>No. of Samples</b>
<b><u>SYNCOAL PRODUCT SHIPMENTS TO CUSTOMERS</u></b>					
Ash Grove Cement Regular	1.73	9.24	0.71	11,749	9
Bentonite Corporation Blend Regular	3.53 Not Available	8.49	0.70	11,524	4
Pete Lien Regular	1.83	8.99	0.76	11,688	9
Empire Sand & Gravel Regular	1.83	8.99	0.76	11,688	9
Wyoming Lime Regular	1.71	8.29	0.64	11,857	2
Montana Power Units 1&2 DSE Conditioned	17.30	8.16	0.59	9,814	19

#### **4.5 TESTBURN PRODUCT**

No testburns were conducted during the second quarter of 1997.

## **5.0 PROCESS STABILITY/PILOT WORK**

### **5.1 PRODUCT STABILITY**

#### **Cooperative Research and Development Agreement (CRADA) For a Joint Rosebud SynCoal Partnership - US DOE PETC Project**

In January, 1995, the CRADA agreement was initiated with the U.S. Bureau of Mines and U.S. Department of Energy, to determine the effects of different processing environments and treatments on low-rank coal composition and structure. Specific objectives were (1) to study the explosivity and flammability limits of dust from the process and (2) to identify the causes of spontaneous heating of upgraded coals. Other participants in this study were the Amax Coal Company and ENCOAL, who have also experienced similar effects with their upgraded products.

## 6.0 FUTURE WORK AREAS

Work continues on improving product stability and dustiness. Several unforeseen product issues, which were only identified by the demonstration project operation, have changed the required activities for the ACCP Demonstration Project.

- Identifying efficient and effective handling techniques.
- Demonstrating the benefits of SynCoal® in the smaller, more constrained industrial boilers and older, smaller utility boilers.
- Developing additional methods to reduce the product's spontaneous combustion potential.
- Reduce the demonstration plant's operating costs on a per ton basis with a goal of achieving positive cashflow when DOE financial support ends in 1997.

Other areas of future work include the following:

- Continue testing at Colstrip Units 1 & 2 and study the feasibility of a pneumatic feed system into the units.
- Rosebud SynCoal Partnership is continuing to pursue commercialization opportunities focused on next generation projects, both internationally and domestically with unique niche markets that can benefit from SynCoal® in the short term. These efforts have been generating a number of prospects, but have not resulted in any new definitive projects yet.
- Rosebud SynCoal has been and is still vigorously marketing the SynCoal® product. Industrial customers, both in Montana and out of state have been targeted. Although SynCoal® has been tested in their facilities and has proven to be a beneficial fuel for their operations, our prices cannot compete with the natural gas prices. In the last quarter of 1996, natural gas prices have increased significantly; however, customers are not willing to change their fuel supply source unless the prices would remain at a high level and many have contracted for a several year period.
- Look at the feasibility of purchasing a truck to haul SynCoal® to Colstrip Units 1 & 2. Currently a truck and driver are being hired from a private trucking company.
- Rosebud SynCoal has requested a 13-month, no cost time extension of the Cooperative Agreement. The purpose is to provide additional time to complete the

goals of the Phase IIIB work and to allow the Department of Energy an opportunity to evaluate a proposed restructuring of the Cooperative Agreement.

- Wyoming Lime has informed us that they plan to install a 120 ton SynCoal® silo in the near future which will allow them to at least double their usage which would be 80 tons or more per day.
- Plans are being made to make some plant modifications in order to make a single SynCoal® product for all customers. This product will be an 80% coarse and 20% fines blend. The major modification would be to tightly enclose the conveyor from the T-95 silo to the A tipple. This would allow us to load railcars with the product which we cannot do now because of dust problems. The blend is proving to be a less spontaneous combustible product, and should allow us to realize a considerable savings in the usage of CO<sub>2</sub> in the inert gas system.



## **APPENDIX A**

### **Significant Accomplishments from Origination of Project to Date**

## **SIGNIFICANT ACCOMPLISHMENTS (SINCE CONCEPT INCEPTION)**

- 1981 September** • Western Energy contracts Mountain States Energy to review LRC upgrading concept called the Greene process.
- 1982 June** • Mountain States Energy built and tested a small batch processor in Butte, Montana.
- 1984 November** • Initial operation of a 150 lb/hr continuous pilot plant modeling the Greene drying process at Montana Tech's Mineral Research Center in Butte, Montana.
- December** • Initial patent application filed for the Greene process, December 1984.
- 1985 November** • Added product cooling and cleaning capability to the pilot plant.
- 1986 January** • Initiated process engineering for a demonstration-size Advanced Coal Conversion Process (ACCP) facility.
- October** • Completed six month continuous operating test at the pilot plant with over 3,000 operating hours producing approximately 200 tons of SynCoal<sup>®</sup>.
- Western Energy submitted a Clean Coal I proposal to DOE for the ACCP Demonstration Project in Colstrip, Montana, October 18, 1986.
- December** • Western Energy's Clean Coal proposal identified as an alternate selection by DOE.
- 1987 November** • Internal Revenue Service issued a private letter ruling designating the ACCP product as a "qualified fuel" under Section 29 of the IRS code, November 6, 1987.
- 1988 February** • First U.S. patent issued February 16, 1988, No. 4, 725,337.
- May** • Western Energy submitted an updated proposal to DOE in response to the Clean Coal II solicitation, May 23, 1988.
- December** • Western Energy was selected by DOE to negotiate a Cooperative Agreement under the Clean Coal I program.

**SIGNIFICANT ACCOMPLISHMENTS (cont'd.)  
(SINCE CONCEPT INCEPTION)**

- |                     |   |
|---------------------|---|
| <b>1989 May</b>     | <ul style="list-style-type: none"> <li>• Second U.S. patent issued March 7, 1989, No. 4, 810,258.</li> </ul>  |
| <b>1990 June</b>    | <ul style="list-style-type: none"> <li>• Reach a negotiated agreement with DOE on the Cooperative Agreement, June 13, 1990.</li> </ul>  |
| <b>September</b>    | <ul style="list-style-type: none"> <li>• Signed Cooperative Agreement, after Congressional approval, September 13, 1990.</li> <li>• Contracted project engineering with Stone &amp; Webster Engineering Corporation, September 17, 1990.</li> </ul> |
| <b>December</b>     | <ul style="list-style-type: none"> <li>• Formed Rosebud SynCoal Partnership, December 5, 1990.</li> <li>• Started construction on the Colstrip site.</li> </ul>   |
| <b>1991 March</b>   | <ul style="list-style-type: none"> <li>• Novated the Cooperative Agreement to the Rosebud SynCoal Partnership, March 25, 1991.</li> <li>• Formal ground breaking ceremony in Colstrip, Montana, March 28, 1991.</li> </ul>                          |
| <b>December</b>     | <ul style="list-style-type: none"> <li>• Initiated commissioning of the ACCP Demonstration Facility.</li> </ul>   |
| <b>1992 April</b>   | <ul style="list-style-type: none"> <li>• Completed construction of the ACCP Demonstration Facility and entered Phase III, Demonstration Operation.</li> </ul>   |
| <b>June</b>         | <ul style="list-style-type: none"> <li>• Formal dedication ceremony for the ACCP Demonstration Project in Colstrip, Montana, June 25, 1992.</li> </ul>  |
| <b>August</b>       | <ul style="list-style-type: none"> <li>• Successfully tested product handling by shipping 40 tons of SynCoal<sup>®</sup> product to MPC's Unit #3 by truck.</li> </ul>  |
| <b>October</b>      | <ul style="list-style-type: none"> <li>• Completed 81 hour continuous coal run 10/2/92.</li> </ul>  |
| <b>November</b>     | <ul style="list-style-type: none"> <li>• Converted to a single process train operation.</li> </ul>  |
| <b>December</b>     | <ul style="list-style-type: none"> <li>• Produced a passivated product with a two-week storage life.</li> </ul>   |
| <b>1993 January</b> | <ul style="list-style-type: none"> <li>• Produced 200 tons of passivated product that lasted 13 days in the open storage pile.</li> </ul>   |
| <b>February</b>     | <ul style="list-style-type: none"> <li>• The plant had a 62 percent operating availability between January 1 and February 15.</li> </ul>  |

**SIGNIFICANT ACCOMPLISHMENTS (cont'd.)  
(SINCE CONCEPT INCEPTION)**

- |                   |   |
|-------------------|---|
| <b>1993 March</b> | <ul style="list-style-type: none"><li>• Identified an environmentally compatible dust suppressant that inhibits fugitive dust from the SynCoal® product. Completed annual Mine Safety and Health Administration safety training.</li></ul>  |
| <b>June</b>       | <ul style="list-style-type: none"><li>• Initiated deliveries of SynCoal® under long-term contracts with industrial customer.</li></ul>  |
| <b>July</b>       | <ul style="list-style-type: none"><li>• Identified a conditioned method that inhibits spontaneous combustion and dust.</li></ul>  |
| <b>August</b>     | <ul style="list-style-type: none"><li>• State evaluated emissions, and the ACCP process is in compliance with air quality permit. ACCP Demonstration Facility went commercial on August 10, 1993.</li></ul>   |
| <b>September</b>  | <ul style="list-style-type: none"><li>• Tested nearly 700 tons of BNI lignite as a potential process feedstock achieving approximately 11,000 Btu/lb heating value and substantially reducing the sulfur in the resultant product.</li><li>• Tested over 500 tons of BNI lignite.</li><li>• Stored approximately 9,000 tons of SynCoal® in inerted product silos and stabilized 2,000 to 3,000 tons in a managed open stockpile.</li><li>• Operated at an 84 percent operating availability and a 62 percent capacity factor for the month.</li></ul> |
| <b>October</b>    | <ul style="list-style-type: none"><li>• Processed more coal since resuming operation in August than during the entire time from initial startup with the summer's maintenance outage (approximately 15 months).</li></ul>   |
| <b>October</b>    | <ul style="list-style-type: none"><li>• Tested North Dakota lignite as a potential process feedstock, achieving nearly 11,000 Btu/lb heating value and substantially reducing the sulfur content in the resultant product.</li></ul>  |
| <b>November</b>   | <ul style="list-style-type: none"><li>• Operated at an 88 percent operating availability and a 74 percent capacity factor for the month.</li></ul>  |

**SIGNIFICANT ACCOMPLISHMENTS (cont'd.)  
(SINCE CONCEPT INCEPTION)**

- |                      |   |
|----------------------|---|
| <b>1993 December</b> | <ul style="list-style-type: none"><li>• Shipped 16,951 tons of SynCoal® to various customers.</li></ul>   |
| <b>1994 January</b>  | <ul style="list-style-type: none"><li>• Shipped 18,754 tons of SynCoal® to various customers.</li><li>• Completed 48 tph stability SynCoal® stabilization process step design.</li><li>• Completed stability reactor testing.</li></ul>       |
| <b>February</b>      | <ul style="list-style-type: none"><li>• The plant had a 67 percent operating availability.</li><li>• Completed 8 tph SynCoal® stabilization process step design.</li></ul>  |
| <b>March</b>         | <ul style="list-style-type: none"><li>• Completed a 50/50 SynCoal® blend testburn at MPC's J.E. Corette plant.</li></ul>  |
| <b>April</b>         | <ul style="list-style-type: none"><li>• Completed 75/25 SynCoal® blend followup testburn at MPC's J.E. Corette plant.</li></ul>   |
| <b>May</b>           | <ul style="list-style-type: none"><li>• Began regular shipments of SynCoal® fines to industrial customers.</li><li>• Exceeded proforma average monthly sales levels for the first time since startup.</li></ul>                               |
| <b>June</b>          | <ul style="list-style-type: none"><li>• Concluded 30 day, 1,000 mile covered hopper rail car test shipment.</li><li>• Increased industrial sales to 39 percent of total (7,350 tons of 18,633).</li></ul>                                     |
| <b>July</b>          | <ul style="list-style-type: none"><li>• Supported an additional 30-day testburn at MPC's J.E. Corette plant.</li><li>• Continued preparing for annual maintenance and facility improvement outage to begin August 19.</li></ul>               |
| <b>August</b>        | <ul style="list-style-type: none"><li>• Began the annual maintenance and facility improvement outage scheduled on August 19.</li><li>• Completed a conceptual design incorporating SynCoal® processing at MPC's J.E. Corette plant.</li></ul> |

**SIGNIFICANT ACCOMPLISHMENTS (cont'd.)  
(SINCE CONCEPT INCEPTION)**

- 1994 September**
- Completed the annual maintenance and facility improvement outage on September 11.
  - Held an open house and tour on September 20 to raise public and market awareness of SynCoal®.
  - Completed conceptual design for an ACCP plant expansion incorporating the process stability step.
- October**
- Scheduled testburns with two industrial users for November 1994
  - Tentatively scheduled two small additional testburns during December 1994.
- November**
- Conducted testburns with two industrial users.
  - Scheduled an additional testburn during December 1994.
  - Scheduled to reestablish deliveries to Continental Lime in Townsend, Montana.
- December**
- Conducted testburns with one additional user.
  - Tentatively scheduled two additional testburns during January 1995.
  - Rescheduled to reestablish deliveries to Continental Lime in Townsend, Montana.
- 1995 January**
- Conducted testburns with an additional industrial user.
  - Tentatively scheduled two additional testburns during February
- February**
- Continued testburn with an industrial user.
  - Supplied a short test at a small utility plant.
  - Tentatively scheduled two additional testburns during March.
- March**
- Supported a testburn with an industrial user.
  - Supplied a short test at a small heat plant.
  - Record monthly sales volume of 28,548 tons or 118 percent of original design proforma.

**SIGNIFICANT ACCOMPLISHMENTS (cont'd.)  
(SINCE CONCEPT INCEPTION)**

- 1995 April**
- Set monthly availability and capacity records for the third consecutive month, with 94% and 129% respectively.
  - Record monthly sales volume of 30,827 tons or 123 percent of original design proforma.
- May**
- Second best monthly availability and capacity factors.
  - Monthly sales volume of 28,705 tons or 115 percent of original design proforma.
- June**
- Completed annual maintenance and modification outage.
- July**
- Set new production record of 127 percent design capacity and 92 percent availability
  - Initiated process waste test with Colstrip Energy Limited Partners
  - Started construction of granular SynCoal<sup>®</sup> truck loadout
  - Received DOE approval to extend the Cooperative Agreement
- August**
- Set new production record of 128 percent design capacity and 93 percent availability
  - Finished process waste test with Colstrip Energy Limited Partners
  - Continued construction of granular SynCoal<sup>®</sup> truck loadout
  - Conducted full train test at Corette with a blend of DSE conditioned granular/fines mix and raw Rosebud coal
- September**
- Wyoming Lime became our newest industrial customer
- October**
- SynCoal<sup>®</sup> truck loadout completed
- November**
- Continued deslagging tests at Milton R. Young station
- December**
- Reached millionth ton processed mark

**SIGNIFICANT ACCOMPLISHMENTS (cont'd.)**

**(SINCE CONCEPT INCEPTION)**

- 1996 February** • The Reference Plant Design draft report was submitted
- 1996 February** • The Reference Plant Design draft report was submitted
- April** • The plant which had shut down was forced to limit production to supply only current industrial customers.
- June** • A sales agreement was reached with Units 1 & 2 for purchase of SynCoal®. The plant resumed full production.
- 1996 July** • Received Department of Energy bid for 25 tons of 14x60 high sulfur SynCoal® for gasifier testing at METC
- August** • Set new monthly availability record of 95.7 percent.
- October** • Delivered 25 tons of high sulfur SynCoal® to the Department of Energy-METC
- November** • Over 800,000 tons of SynCoal® product has been sold.
- ACCP Facility employees honored for working 475,000 hours without a lost time accident
- 1997 March** • Conducted ash yield tests for Globe Metallurgical
- Completed pneumatic unloading test at Montana Power Units 1 and 2
- T-96 silo gate modifications were completed.
- April** • **The SynCoal facility produced its one millionth ton of SynCoal®**
- May** • **Conducted a coke/SynCoal® blend test**